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The 1991 "Neural Information Processing Systems-Natural and Synthetic" (NIPS) was held in Denver Colorado, from 2-5 December 1991. Since its inception in 1987, the NIPS conference has attracted researchers from many disciplines who are applying their expertise to problems in the field of neural networks. The conference and the following two day workshop have become a forum for presenting the latest research results and for leading researchers to gather and exchange ideas. The 1991 conference maintained the high level of excitement of its predecessors. Important new theoretical results were presented concerning the capability and generalization performance of networks.

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Department of Computer Science and Engineering

OREGON GRADUATE INSTITUTE  
OF  
SCIENCE & TECHNOLOGY

19600 N. Wilson Neumann Drive  
Beaverton, Oregon 97006-1999, USA  
Phone 503-696-1151 FAX 503-696-1024

February 4, 1993

Capt. Steven Suddarth, Ph.D.  
AFOSR/NE, Bldg. 410  
Bolling Air Force Base  
Washington, DC 20332

Dear Dr. Suddarth:

YALE U ← This letter and the attached materials constitute the final report for AFOSR Grant 91-0438 which provided \$5,000 for student travel grants for the 1991 Neural Information Processing Systems Conference. The money was used to help 20 students as indicated in the attached list.

Also attached is a copy of the front matter of the proceedings which resulted from NIPS '91. As is evident, many of the students we were able to help made substantial contributions to the conference program. We are very grateful for your generous support and hope that you will be able to continue to support NIPS conferences in the future.

Sincerely,

John Moody  
Associate Professor  
NIPS\*91 General Chairman



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YALE UNIVERSITY

Department of Computer Science and Engineering

OREGON GRADUATE INSTITUTE  
OF  
SCIENCE & TECHNOLOGY

1960 N.W. von Neumann Drive  
Beaverton, Oregon 97006-1999 USA  
Phone 503.690.1151 FAX 503.690.1129

1.*	\$250	Quanfeng Wu	qw0w@andrew.cmu.edu
2.*	\$250	David Plaut	dcp@cs.cmu.edu
3.*	\$250	John Hampshire	hamps@speech2.cs.cmu.edu
4.*	\$250	Frederick Waugh	waugh@curly.harvard.edu
6.*	\$250.	Lori Pratt	pratt@paul.rutgers.edu
7.*	\$250.	Barak Pearlmutter	barak@james.psych.yale
8.*	\$250.	Alexandre Pouget	alex@cajal.edec.edu
9.*	\$250	Steve Fisher	fisher@helmholtz.sdsc.edu
10.*	\$250.	Sowmya Ramachandran	sowmya@cs.utexas.edu
11.*	\$250	Andrew Moore	awm@mit.ai.edu
12.*	\$250.	Zoubin Ghahramani	zoubin@psyche.mit.edu
13.*	\$250.	Ying Zhao	yzhao@ai.mit.edu
14.*	\$250	David Cohn	pablo@cs.washington.edu
15.*	\$250	Steve Nowlan	nowlan@helmholtz.sdsc.edu
16.*	\$250	Sherif Botros	smb@ai.mit.edu
17.*	\$250	Gary Scott	scott@chewi.che.wisc.edu
18.*	\$250	Tony Bell	tony@helmholtz.sdsc.edu
20.*	\$250.	Elizabeth Thomas	cmjv465@hermes.chpc.utexas.edu
22.*	\$250	Tony Zador	zador@cs.yale.edu
23.*	\$250	Antonette Logar	N0801@ttacs1.ttu.edu

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JOHN E. MOODY  
YALE UNIVERSITY

STEVE J. HANSON  
SIEMENS RESEARCH CENTER

RICHARD P. LIPPMANN  
MIT LINCOLN LABORATORY

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# CONTENTS

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## Preface xv

## Part I NEUROBIOLOGY

Models Wanted: Must Fit Dimensions of Sleep and Dreaming . . . . .	3
<i>J. Allan Hobson, Adam N. Mamelak, and Jeffrey P. Sutton</i>	
Stationarity of Synaptic Coupling Strength Between Neurons with Nonstationary Discharge Properties . . . . .	11
<i>Mark Sydorenko and Eric D. Young</i>	
Perturbing Hebbian Rules . . . . .	19
<i>Peter Dayan and Geoffrey Goodhill</i>	
Statistical Reliability of a Blowfly Movement-Sensitive Neuron . . . . .	27
<i>Rob de Ruyter van Steveninck and William Bialek</i>	
The Clusteron: Toward a Simple Abstraction for a Complex Neuron . . . . .	35
<i>Bartlett W. Mel</i>	
Network activity determines spatio-temporal integration in single cells . . . . .	43
<i>Oyvind Bernander, Christof Koch, and Rodney J. Douglas</i>	
Nonlinear Pattern Separation in Single Hippocampal Neurons with Active Dendritic Membrane . . . . .	51
<i>Anthony M. Zador, Brenda J. Claiborne, and Thomas H. Brown</i>	
Self-organisation in real neurons: Anti-Hebb in 'Channel Space'? . . . . .	59
<i>Anthony J. Bell</i>	
Single Neuron Model: Response to Weak Modulation in the Presence of Noise . . . . .	67
<i>A.R. Bulsara, E.W. Jacobs, and F. Moss</i>	
Dual Inhibitory Mechanisms for Definition of Receptive Field Characteristics in a Cat Striate Cortex . . . . .	75
<i>A.B. Bonds</i>	

A comparison between a neural network model for the formation of brain maps and experimental data . . . . .	83
<i>K. Obermayer, K. Schulten, and G.G. Blasdel</i>	
Retinogeniculate Development: The Role of Competition and Correlated Retinal Activity . . . . .	91
<i>Ron Keesing, David G. Stork, and Carla J. Shazz</i>	

## Part II NEURO-DYNAMICS

Locomotion in a Lower Vertebrate: Studies of the Cellular Basis of Rhythmogenesis and Oscillator Coupling . . . . .	101
<i>James T. Buchanan</i>	
Adaptive Synchronization of Neural and Physical Oscillators . . . . .	109
<i>Kenji Doya and Shuji Yoshizawa</i>	
Burst Synchronization without Frequency Locking in a Completely Solvable Network Model . . . . .	117
<i>Heinz Schuster and Christof Koch</i>	
Oscillatory Model of Short Term Memory . . . . .	125
<i>David Horn and Marius Usher</i>	

## Part III SPEECH

Multi-State Time Delay Neural Networks for Continuous Speech Recognition . . .	135
<i>Patrick Haffner and Alex Waibel</i>	
Modeling Applications with the Focused Gamma Net . . . . .	143
<i>Jose C. Principe, Bert de Vries, Jyh Ming Kuo, Pedro Guedes de Oliveira</i>	
Time-Warping Network: A Hybrid Framework for Speech Recognition . . . . .	151
<i>Esther Levin, Roberto Pieraccini, and Enrico Bocchieri</i>	
Improved Hidden Markov Model Speech Recognition Using Radial Basis Function Networks . . . . .	159
<i>Elliot Singer and Richard P. Lippmann</i>	
Connectionist Optimisation of Tied Mixture Hidden Markov Models . . . . .	167
<i>Steve Renals, Nelson Morgan, Hervé Bourlard, Horacio Franco, and Michael Cohen</i>	
Neural Network—Gaussian Mixture Hybrid for Speech Recognition or Density Estimation . . . . .	175
<i>Yoshua Bengio, Renato De Mori, Giovanni Flammia, Ralf Kompe</i>	
JANUS: Speech-to-Speech Translation Using Connectionist and Non-Connectionist Techniques . . . . .	183
<i>Alex Waibel, Ajay N. Jain, Arthru McNair, Joe Tebelskis, Louise Osterholz, Hiroaki Saito, Otto Schmidbauer, Tilo Sloboda, and Monika Wozyczyna</i>	

Forward Dynamics Modeling of Speech Motor Control Using Physiological Data . . . . .	191
<i>Makoto Hirayama, Eric Vatikiotis-Bateson, Mitsuo Kawato, and Michael I. Jordan</i>	
English Alphabet Recognition with Telephone Speech . . . . .	199
<i>Mark Fientz, Ronald A. Cole, and Krist Roginski</i>	

#### Part IV LANGUAGE

Generalization Performance in PARSEC—A Structured Connectionist Parsing Architecture . . . . .	209
<i>Ajay N. Jain</i>	
Constructing Proofs in Symmetric Networks . . . . .	217
<i>Gadi Pinkas</i>	
A Connectionist Learning Approach to Analyzing Linguistic Stress . . . . .	225
<i>Prahlad Gupta and David S. Touretzky</i>	
Propagation Filters in PDS Networks for Sequencing and Ambiguity Resolution . . . . .	233
<i>Ronald A. Sumida and Michael G. Dyer</i>	
A Segment-based Automatic Language Identification System . . . . .	241
<i>Uthman K. Muthusamy and Ronald A. Cole</i>	

#### Part V TEMPORAL SEQUENCES

The Efficient Learning of Multiple Task Sequences . . . . .	251
<i>Satinder P. Singh</i>	
Practical Issues in Temporal Difference Learning . . . . .	259
<i>Gerald Tesauro</i>	
HARMONET: A Neural Net for Harmonizing Chorales in the Style of J.S. Bach . . . . .	267
<i>Hermann Hild, Johannes Feulner, and Wolfram Menzel</i>	
Induction of Multiscale Temporal Structure . . . . .	275
<i>Michael C. Mozer</i>	
Network Model of State-Dependent Sequencing . . . . .	283
<i>Jeffrey P. Sutton, Adam N. Mamelak, and J. Allan Hobson</i>	
Learning Unambiguous Reduced Sequence Descriptions . . . . .	291
<i>Jürgen Schmidhuber</i>	

#### Part VI RECURRENT NETWORKS

Recurrent Networks and NARMA Modeling . . . . .	301
<i>Jerome Connor, Les E. Atlas, and Douglas R. Martin</i>	

Induction of Finite-State Automata Using Second-Order Recurrent Networks . . .	309
<i>Raymond L. Watrous, and Gary M. Kuhn</i>	
Extracting and Learning an Unknown Grammar with Recurrent Neural Networks . . . . .	317
<i>C.L. Giles, C.B. Miller, D. Chen, G.Z. Sun, H.H. Chen, and Y.C. Lee</i>	
Operators and curried functions: Training and analysis of simple recurrent networks . . . . .	325
<i>Janet Wiles and Anthony Bloesch</i>	
Green's Function Method for Fast On-line Learning Algorithm of Recurrent Neural Networks . . . . .	333
<i>Guo-Zheng Sun, Hsing-Hen Chen, and Yee-Chun Lee</i>	
Dynamically-Adaptive Winner-Take-All Networks . . . . .	341
<i>Trent E. Lange</i>	

## Part VII VISION

Information Processing to Create Eye Movements . . . . .	351
<i>David A. Robinson</i>	
Decoding of Neuronal Signals in Visual Pattern Recognition . . . . .	356
<i>Emad N. Eskandar, Barry J. Richmond, John A. Hertz, Lance M. Optican, and Troels Kjer</i>	
Learning How to Teach or Selecting Minimal Surface Data . . . . .	364
<i>Davi Geiger and Ricardo A. Marques Pereira</i>	
Learning to Make Coherent Predictions in Domains with Discontinuities . . . . .	372
<i>Suzanna Becker and Geoffrey E. Hinton</i>	
Recurrent Eye Tracking Network Using a Distributed Representation of Image Motion . . . . .	380
<i>P.A. Viola, S.G. Lisberger, and T.J. Sejnowski</i>	
Against Edges: Function Approximation with Multiple Support Maps . . . . .	388
<i>Trevor Darrell and Alex Pentland</i>	
Markov Random Fields Can Bridge Levels of Abstraction . . . . .	396
<i>Paul R. Cooper and Peter N. Prokopowicz</i>	
Illumination and View Position in 3D Visual Recognition . . . . .	404
<i>Amnon Shashua</i>	
Hierarchical Transformation of Space in the Visual System . . . . .	412
<i>Alexandre Pouget, Stephen A. Fisher, and Terrence J. Sejnowski</i>	
VISIT: A Neural Model of Covert Visual Attention . . . . .	420
<i>Subusai Ahmad</i>	
Visual Grammars and their Neural Nets . . . . .	428
<i>Eric Mjølness</i>	

Learning to Segment Images Using Dynamic Feature Binding . . . . .	436
<i>Michael C. Mozer, Richard S. Zemel, and Marlene Behrmann</i>	
Combined Neural Network and Rule-Based Framework for Probabilistic Pattern Recognition and Discovery . . . . .	444
<i>Hayit K. Greenspan, Rodney Goodman, and Rama Chellappa</i>	
Linear Operator for Object Recognition . . . . .	452
<i>Ronen Barri and Shimon Ullman</i>	
3D Object Recognition Using Unsupervised Feature Extraction . . . . .	460
<i>Nathan Intrator, Josh I. Gold, Heinrich H. Bülthoff, and Shimon Edelman</i>	
<b>Part VIII OPTICAL CHARACTER RECOGNITION</b>	
Structural Risk Minimization for Character Recognition . . . . .	471
<i>I. Guyon, V. Vapnik, B. Boser, L. Bottou, and S.A. Solla</i>	
Image Segmentation with Networks of Variable Scales . . . . .	480
<i>Hans P. Graf, Craig R. Nohl, and Jan Ben</i>	
Multi-Digit Recognition Using a Space Displacement Neural Network . . . . .	488
<i>Ofer Matan, Christopher J.C. Burges, Yann Le Cun, and John S. Denker</i>	
A Self-Organizing Integrated Segmentation and Recognition Neural Net . . . . .	496
<i>Jim Keeler and David E. Rumelhart</i>	
Recognizing Overlapping Hand-Printed Characters by Centered-Object Integrated Segmentation and Recognition . . . . .	504
<i>Gale L. Martin and Mosfeq Rashid</i>	
Adaptive Elastic Models for Hand-Printed Character Recognition . . . . .	512
<i>Geoffrey E. Hinton, Christophe K.I. Williams, and Michael D. Revow</i>	
<b>Part IX CONTROL AND PLANNING</b>	
Obstacle Avoidance through Reinforcement Learning . . . . .	523
<i>Tony J. Prescott and John E.W. Mayhew</i>	
Active Exploration in Dynamic Environments . . . . .	531
<i>Sebastian B. Thrun and Knut Möller</i>	
Oscillatory Neural Fields for Globally Optimal Path Planning . . . . .	539
<i>Michael Lemmon</i>	
Recognition of Manipulated Objects by Motor Learning . . . . .	547
<i>Hiroaki Gomi and Mitsuo Kawato</i>	
Refining PID Controllers using Neural Networks . . . . .	555
<i>Gary M. Scott, Jude W. Shaulik, and W. Harmon Ray</i>	
Fast Learning with Predictive Forward Models . . . . .	563
<i>Carlos Brody</i>	

Fast, Robust Adaptive Control by Learning only Forward Models . . . . .	571
<i>Andrew W. Moore</i>	
Reverse TDNN: An Architecture for Trajectory Generation . . . . .	579
<i>Patrice Simard and Yann Le Cun</i>	
Learning Global Direct Inverse Kinematics . . . . .	589
<i>David DeMers and Kenneth Kreutz-Delgado</i>	
A Neural Net Model for Adaptive Control of Saccadic Accuracy by Primate Cerebellum and Brainstem . . . . .	595
<i>Paul Dean, John E.W. Mayhew, and Pat Langdon</i>	
Learning in the Vestibular System: Simulations of Vestibular Compensation Using Recurrent Back-Propagation . . . . .	603
<i>Thomas J. Anastasio</i>	
A Cortico-Cerebellar Model that Learns to Generate Distributed Motor Commands to Control a Kinematic Arm . . . . .	611
<i>N.E. Berthier, S.P. Singh, A.G. Barto, and J.C. Houk</i>	
A Computational Mechanism to Account for Averaged Modified Hand Trajectories . . . . .	619
<i>Ealan A. Henis and Tamar Flash</i>	
Simulation of Optimal Movements Using the Minimum-Muscle-Tension-Change Model . . . . .	627
<i>Menashe Dornay, Yoji Uno, Mitsuo Kawato, and Ryoji Suzuki</i>	

## Part X APPLICATIONS

ANN Based Classification for Heart Defibrillators . . . . .	637
<i>M. Jabri, S. Pickard, P. Leong, Z. Chi, B. Flower, and Y. Xie</i>	
Neural Network Diagnosis of Avascular Necrosis from Magnetic Resonance Images . . . . .	645
<i>Armando Manduca, Paul Christy, and Richard Ehman</i>	
Neural Network Analysis of Event Related Potentials and Electroencephalogram Predicts Vigilance . . . . .	651
<i>Rita Venturini, William W. Lytton, and Terrence J. Sejnowski</i>	
Neural Control for Rolling Mills: Incorporating Domain Theories to Overcome Data Deficiency . . . . .	659
<i>Martin Röschelien, Reimar Hofmann, and Volker Tresp</i>	
Fault Diagnosis of Antenna Pointing Systems Using Hybrid Neural Network and Signal Processing Models . . . . .	667
<i>Padhraic Smyth and Jeff Mellstrom</i>	
Multimodular Architecture for Remote Sensing Options . . . . .	675
<i>Sylvie Thiria, Carlos Mejia, Fouad Badran, Michel Crépon</i>	

Principled Architecture Selection for Neural Networks: Application to Corporate Bond Rating Prediction . . . . .	683
<i>John Moody and Joachim Ueans</i>	
Adaptive Development of Connectionist Decoders for Complex Error-Correcting Codes . . . . .	691
<i>Sheri L. Gish and Mario Blaum</i>	
Application of Neural Network Methodology to the Modelling of the Yield Strength in a Steel Rolling Plate Mill . . . . .	698
<i>Ah Chung Tsoi</i>	
Computer Recognition of Wave Location in Graphical Data by a Neural Network . . . . .	706
<i>Donald T. Freeman</i>	
A Neural Network for Motion Detection of Drift-Balanced Stimuli . . . . .	714
<i>Hilary Tunley</i>	
Neural Network Routing for Random Multistage Interconnection Networks . . . . .	722
<i>Mark W. Goudreau and C. Lee Giles</i>	
Networks for the Separation of Sources that are Superimposed and Delayed . . . . .	730
<i>John C. Platt and Federico Faggin</i>	

## Part XI IMPLEMENTATION

CCD Neural Network Processors for Pattern Recognition . . . . .	741
<i>Alice M. Chiang, Michael L. Chuang, and Jeffrey R. LaFranchise</i>	
A Parallel Analog CCD/CMOS Signal Processor . . . . .	748
<i>Charles F. Neugebauer and Amnon Yariv</i>	
Direction Selective Silicon Retina that uses Null Inhibition . . . . .	756
<i>Ronald G. Benson and Tobi Delbrück</i>	
A Contrast Sensitive Silicon Retina with Reciprocal Synapses . . . . .	764
<i>Kwabena A. Boahen and Andreas G. Andreou</i>	
A Neurocomputer Board Based on the ANNA Neural Network Chip . . . . .	773
<i>Eduard Säckinger, Bernhard E. Boser, and Lawrence D. Jackel</i>	
Software for ANN training on a Ring Array Processor . . . . .	781
<i>Phil Kohn, Jeff Bilmes, Nelson Morgan, and James Beck</i>	
Constrained Optimization Applied to the Parameter Setting Problem for Analog Circuits . . . . .	789
<i>David Kirk, Kurt Fleischer, Lloyd Watts, and Alan Barr</i>	
Segmentation Circuits Using Constrained Optimization . . . . .	797
<i>John G. Harris</i>	

Analog LSI Implementation of an Auto-Adaptive Network for Real-Time Separation of Independent Signals . . . . .	805
<i>Marc H. Cohen, Phillippe O. Pouliquen, and Andreas G. Andreou</i>	
Temporal Adaptation in a Silicon Auditory Nerve . . . . .	813
<i>John Lazzaro</i>	
Optical Implementation of a Self-Organizing Feature Extractor . . . . .	821
<i>Dana Z. Anderson, Claus Benkers, Verena Hebler, Ju-Seog Jang, Don Montgomery, and Mark Saffman</i>	
<b>Part XII LEARNING AND GENERALIZATION</b>	
Principles of Risk Minimization for Learning Theory . . . . .	831
<i>V. Vapnik</i>	
Bayesian Model Comparison and Backprop Nets . . . . .	839
<i>David J. C. MacKay</i>	
The Effective Number of Parameters: An Analysis of Generalization and Regularization in Nonlinear Learning Systems . . . . .	847
<i>John E. Moody</i>	
Estimating Average-Case Learning Curves Using Bayesian, Statistical Physics and VC Dimension Methods . . . . .	855
<i>David Hausler, Michael Kearns, Manfred Opper, and Robert Schapire</i>	
Constant-Time Loading of Shallow 1-Dimensional Networks . . . . .	863
<i>Stephen Judd</i>	
Experimental Evaluation of Learning in a Neural Microsystem . . . . .	871
<i>Joshua Alspector, Anthony Jayakumar, and Stephan Luna</i>	
Threshold Network Learning in the Presence of Equivalences . . . . .	879
<i>John Shawe-Taylor</i>	
Gradient Descent: Second Order Momentum and Saturating Error . . . . .	887
<i>Barak Pearlmutter</i>	
Tangent Prop--A formalism for specifying selected invariances in an adaptive network . . . . .	895
<i>Patrice Simard, Bernard Victorri, Yann Le Cun, and John Denker</i>	
Polynomial Uniform Convergence of Relative Frequencies to Probabilities . . . . .	904
<i>Alberto Bertoni, Paola Campadelli, Anna Morpurgo, and Sandra Panizza</i>	
Unsupervised learning of distributions on binary vectors using 2-layer networks . . . . .	912
<i>Yoav Freund and David Hausler</i>	
Incrementally Learning Time-varying Half-planes . . . . .	920
<i>Anthony Kuh, Thomas Petsche, and Ron L. Rivest</i>	



The VC-Dimension versus the Statistical Capacity of Multilayer Networks . . . .	928
<i>Chuanyi Ji and Demetris Psaltis</i>	
Some Approximation Properties of Projection Pursuit Learning Networks . . . .	936
<i>Ying Zhao and Christopher G. Atkeson</i>	
Neural Computing with Small Weights . . . . .	944
<i>Kai-Young Siu and Jehoshua Bruck</i>	
A Simple Weight Decay Can Improve Generalization . . . . .	950
<i>Anders Krogh and John A. Hertz</i>	
Best-First Model Merging for Dynamic Learning and Recognition . . . . .	958
<i>Stephen M. Omohundro</i>	

### Part XIII ARCHITECTURES AND ALGORITHMS

Rule Induction through Integrated Symbolic and Subsymbolic Processing . . . .	969
<i>Clayton McMillan, Michael C. Mozer, and Paul Smolensky</i>	
Interpretation of Artificial Neural Networks: Mapping Knowledge-Based Neural Networks into Rules . . . . .	977
<i>Geoffrey Towell and Jude W. Shavlik</i>	
Hierarchies of adaptive experts . . . . .	985
<i>Michael I. Jordan and Robert A. Jacobs</i>	
Adaptive Soft Weight Tying using Gaussian Mixtures . . . . .	993
<i>Steven J. Nowlan and Geoffrey E. Hinton</i>	
Repeat Until Bored: A Pattern Selection Strategy . . . . .	1001
<i>Paul W. Munro</i>	
Towards Faster Stochastic Gradient Search . . . . .	1009
<i>Christian Darken and John Moody</i>	
Competitive Anti-Hebbian Learning of Invariants . . . . .	1017
<i>Nicol N. Schraudolph and Terrence J. Sejnowski</i>	
Merging Constrained Optimisation with Deterministic Annealing to "Solve" Combinatorially Hard Problems . . . . .	1025
<i>Paul Stolorz</i>	
Kernel Regression and Backpropagation Training with Noise . . . . .	1033
<i>Patri Koistinen and Lasse Holmstrom</i>	
Splines, Rational Functions and Neural Networks . . . . .	1040
<i>Robert C. Williamson and Peter L. Bartlett</i>	
Networks with Learned Unit Response Functions . . . . .	1048
<i>John Moody and Norman Yarvin</i>	
Learning in Feedforward Networks with Nonsmooth Functions . . . . .	1056
<i>Nicholas J. Redding and T. Downs</i>	

Iterative Construction of Sparse Polynomial Approximations . . . . .	1064
<i>Terence D. Sanger, Richard S. Sutton, and Christopher J. Mathews</i>	
Node Splitting: A Constructive Algorithm for Feed-Forward Neural Networks . . .	1072
<i>Mike Wynne-Jones</i>	
Information Measure Based Skeletonisation . . . . .	1080
<i>Soumya Ramachandran and Lorian Y. Pratt</i>	
Data Analysis Using G/Splines . . . . .	1088
<i>David Rogers</i>	
Unsupervised Classifiers, Mutual Information and 'Phantom Targets' . . . . .	1096
<i>John S. Bridle, Anthony J.R. Heading, and David J.C. MacKay</i>	
A Network of Localized Linear Discriminants . . . . .	1102
<i>Martin S. Glassman</i>	
A Weighted Probabilistic Neural Network . . . . .	1110
<i>David Montana</i>	
Network generalization for production: Learning and producing styled letterforms . . . . .	1118
<i>Igor Grebert, David G. Stork, Ron Keesing, and Steve Mims</i>	
Shooting Craps in Search of an Optimal Strategy for Training Connectionist Pattern Classifiers . . . . .	1125
<i>J.B. Hampshire II and B.V.K. Vijaya Kumar</i>	
Improving the Performance of Radial Basis Function Networks by Learning Center Locations . . . . .	1133
<i>Dietrich Wetschereck and Thomas Dietterich</i>	
A Topographic Product for the Optimization of Self-Organizing Feature Maps . . .	1141
<i>Hans-Ulrich Bauer, Klaus Pawelzik, and Theo Geisel</i>	
<b>Part XIV PERFORMANCE COMPARISONS</b>	
Human and Machine 'Quick Modeling' . . . . .	1151
<i>Jakob Bernasconi and Karl Gustafson</i>	
A Comparison of Projection Pursuit and Neural Network Regression Modeling . . . . .	1159
<i>Jenq-Neng Huang, Hang Li, Martin Maechler, R. Douglas Martin, and Jim Schimert</i>	
Benchmarking Feed-Forward Neural Networks: Models and Measures . . . . .	1167
<i>Leonard G.C. Hamey</i>	
Keyword Index . . . . .	1175
Author Index . . . . .	1184

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## PREFACE

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This volume contains 144 papers summarizing the talks and posters presented at the fifth NIPS conference (short for "Neural Information Processing Systems—Natural and Synthetic"), held in Denver, Colorado, from 2–5 December 1991. Since its inception in 1987, the NIPS conference has attracted researchers from many disciplines who are applying their expertise to problems in the field of neural networks. The conference and the following two-day workshop have become a forum for presenting the latest research results and for leading researchers to gather and exchange ideas.

The 1991 conference maintained the high level of excitement of its predecessors. Important new theoretical results were presented concerning the capability and generalization performance of networks. Of particular interest are papers included in this volume by Vapnik, MacKay, Haussler, and others, which describe how to relate the complexity of networks to generalization performance on unseen test data. Many new network architectures were described. Some integrate expert system rules with networks, build hierarchies of networks, use radial basis function hidden nodes, and impose pre-specified invariance on the final solution. Neurobiological papers analyzed and modeled neurons in the hippocampus, in cat striate cortex, and in the blowfly. They also modeled biological networks that control eye movement, form topological maps, and compensate for head movement. Successful applications of neural networks were described in the areas of speech, vision, language, control, medical monitoring, and system diagnostics. Of particular interest was a paper by Tesauro, which demonstrated how a network could be trained to play backgammon at an expert level; papers by Jain, Watrous, and Giles, which described approaches to learning grammars; hybrid hidden-Markov-model/neural-network speech recognizers described by Haffner, Levin, Singer, Renals, and Bengio; papers on optical character recognition; a paper by Jabri, which describes a network to control a wearable heart defibrillator; a paper by Smyth for diagnosis of large-dish antenna pointing systems; and a paper by Röscheisen concerning control of force on rollers in steel rolling mills. Papers also described new analog and digital VLSI chips, systems for neural network implementation, and compared neural network and statistical approaches to pattern classification.

An historical milestone was reached this year, NIPS-91 was the fifth NIPS conference since the first conference was held in 1987. To mark this anniversary, we decided to review the history of events that led to the foundation of the NIPS conference and to discuss the evolution of the conference since its foundation. The following history is based in part on the recollections of Jim Bower, Larry Jackel, and Ed Posner. Some of this history was presented by Larry Jackel at the opening banquet.

While the first NIPS conference met in 1987, its origins can be traced back to the "Hopfest" meetings named in honor of John Hopfield, held at Caltech. The first few, 1984-1986, were organized by Ed Posner of Caltech. These meetings met in the fall and included researches mainly from the Caltech campus and JPL. In 1985, Larry Jackel of Bell Labs and Demetri Psaltis of Caltech organized the first of what were to become the "Snowbird" meetings. The meetings were intended to be small informal workshops and convened in Santa Barbara. Twenty people were invited, but news of the meeting spread by word of mouth, so that attendance ended up growing to 60. In 1986, the meeting reconvened at Snowbird, which offered better snow conditions. Jackel, Psaltis, and the other organizers intended to keep the attendance down to 100 people, but the interest was so great that many people were turned away even after the attendance was capped at 160. The first Snowbird proceedings was edited by John Denker of Bell Labs and published by the American Institute of Physics (AIP) press.

In 1986, the Snowbird meeting was the only neural network conference, and it clearly could not accommodate the exploding numbers of researchers becoming interested in the field and still maintain the character of a small workshop. To respond to demand, the organizers decided to make Snowbird a more closed meeting, but to set in motion organization of a large meeting that would be open to all interested. The goal was to have a non-commercial meeting, dedicated to scholarship, which would capture some of the flavor of the workshop. The Snowbird organizers nominated a committee with Ed Posner as General Chairman and Yaser Abu Mostafa as Program Chairman (both of Caltech), to organize and run the 1987 NIPS conference, which was officially sponsored by the IEEE Information Theory Society. Denver was chosen as the site due to its central geographical location, ease of access by air, and close proximity to the mountains and the University of Colorado at Boulder.

The 1987 organizers designed the NIPS conference to have many of the advantages of a workshop, while still accommodating a large audience. To maximize scientific interchange, they decided to limit the oral presentations to a single stream, have posters be the majority of presentations, and include poster preview as well as formal poster sessions. Furthermore, a set of post-conference workshops was organized at the Copper Mountain ski resort after the main conference to enable small groups to discuss specific topics. The 1987 conference proved to be a great success, with about 450 attendees and 91 papers making it into the proceedings. Dana Z. Anderson of CU Boulder edited the proceedings, which were published by the AIP press and are now informally known as NIPS Volume 0.

Since 1987, some changes and refinements have been made, but the basic structure of the conference has remained the same. The NIPS 1988 proceedings (NIPS Volume 1, edited by David Touretzky of Carnegie Mellon) were the first published by Morgan Kaufmann. Also in 1988, the post-conference workshops were moved to Keystone, CO. The refinement processes (three reviewers instead of two), a more cross-disciplinary grouping of presenta-

tions, finer presentation categories, and the addition of five-minute oral poster spotlight presentations. A major and very successful addition to the 1991 conference was the introduction of a day of tutorials preceding the main conference. The 1991 workshops were held at Vail, which proved to be a popular move.

Finally, 1991 marked the drafting of articles of incorporation for the Neural Information Processing Systems Foundation, which will be responsible for the continuity of the NIPS conference in future years. The initial board of directors of the foundation consists of the 1987 to 1992 NIPS General Chairs (Ed Posner of Cal Tech, Terry Sejnowski of the Salk Institute and UCSD, Scott Kirkpatrick of IBM, Richard Lippmann of MIT Lincoln Labs, John Moody of Yale, and Stephen Hanson of Siemens), a member of the IEEE Information Theory Society (Terry Fine of Cornell), and our legal counsel (Philip Sotol).

The NIPS conference continues to be an exciting, successful meeting due to the efforts of a large group of people. We would first like to thank all the other members of the 1991 program and organizing committees who helped make this conference possible. In particular, we would like to thank Renate Crowley of Siemens for her extensive work throughout the year as the conference secretary and both Renate and Kate Fuqua of CU Boulder for running the conference desk so smoothly. Student contributions are an important part of the NIPS program, and we gratefully thank Tom McKenna of ONR and Steve Suddarth of AFOSR for the student travel funding provided by their agencies. Finally, we thank everyone who attended and submitted papers and the 105 referees who carefully read and reviewed 20 papers each.

*John Moody*

*Stephen Hanson*

*Richard Lippmann*

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